Chemical Degradation of Concrete: Alkali-Silica Reaction (ASR)
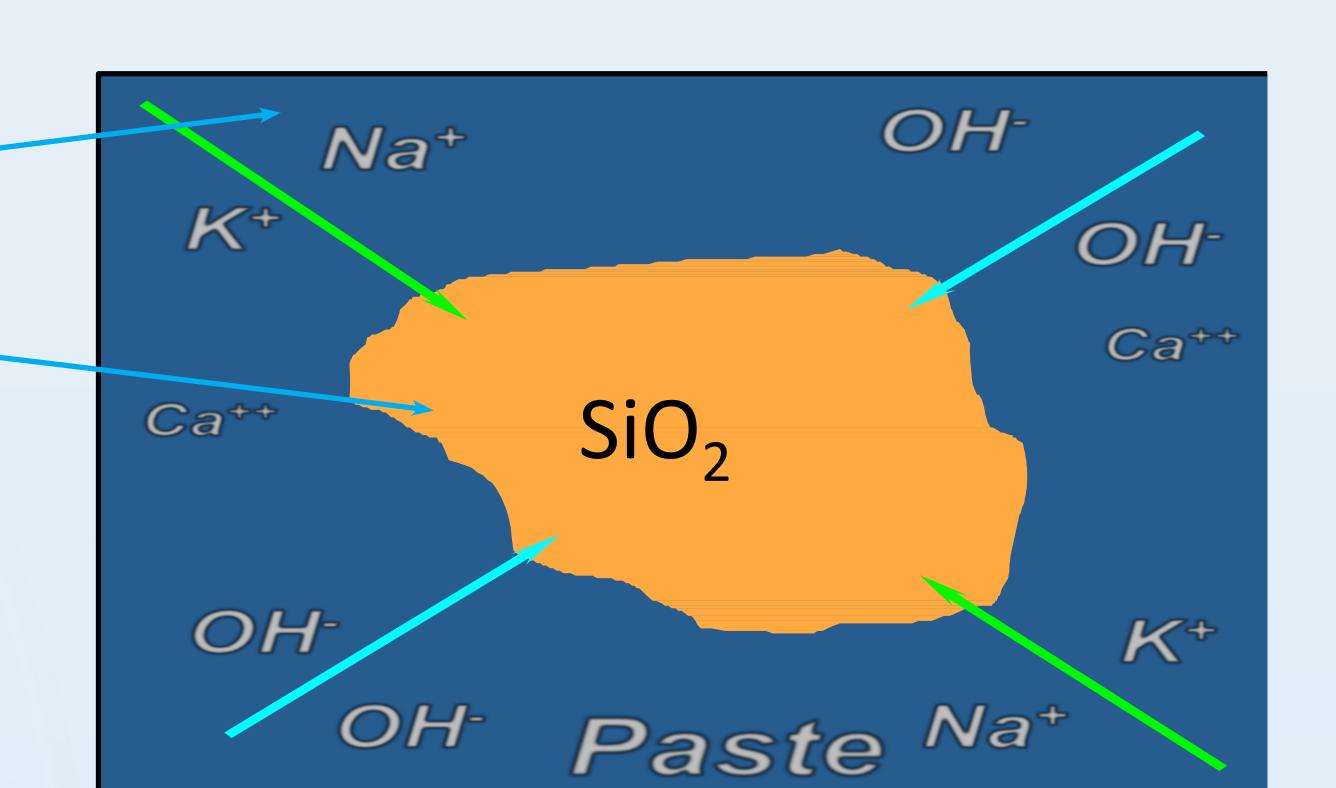
ASR Mechanism in Concrete
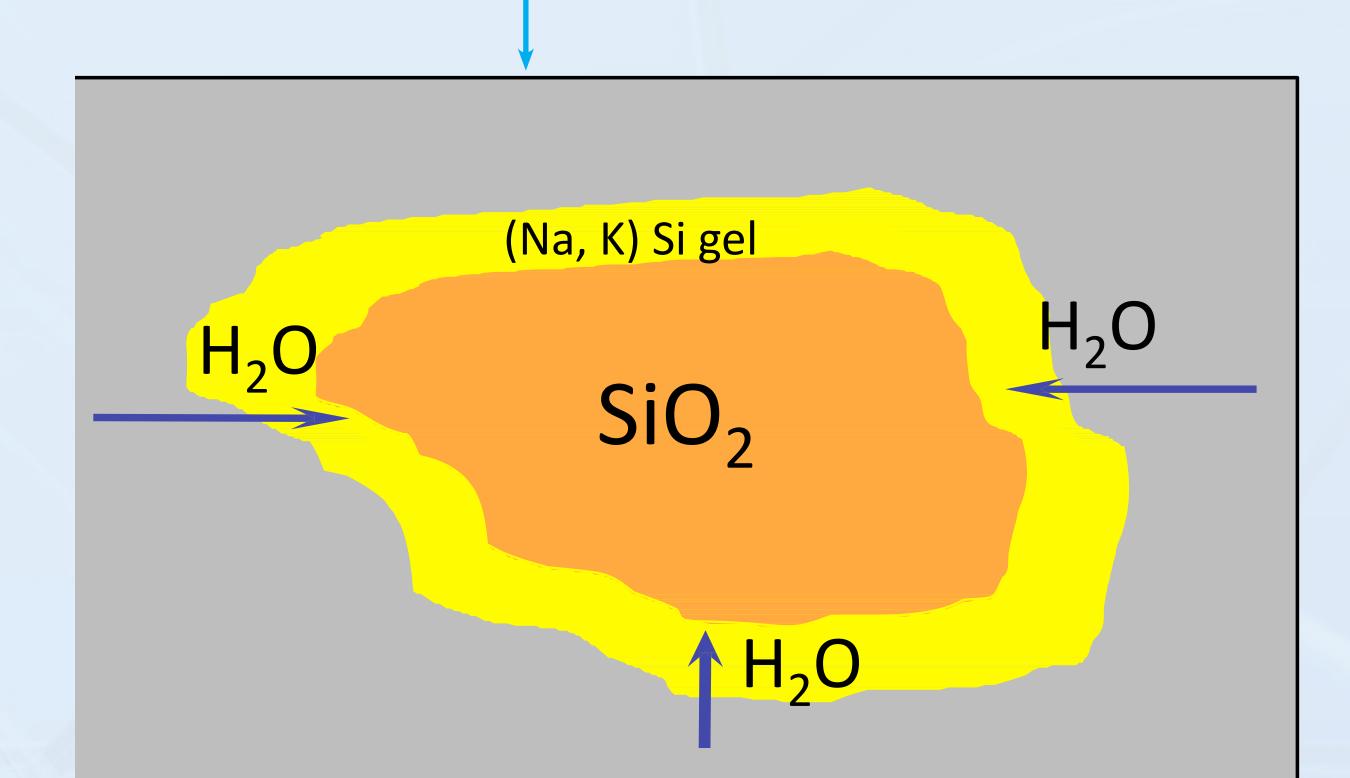
CONCRETE MODEL

- Cement Paste
- Reactive Siliceous Aggregate
- Pore solution
- Sodium (Na+), Potassium (K+), Hydroxide (OH-) and minor amounts of Calcium (Ca++) and other ions

If silica (SiO_2) is reactive it may be "attacked" first by OH- and then by Na+ and K+ ions [in the presence of water (H_2O)].....
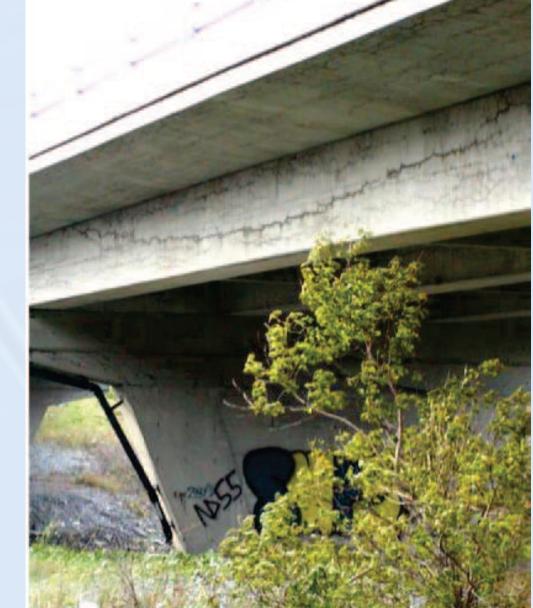

...forming a alkali-silica gel composed predominantly of silicon (Si), potassium (K) and sodium (Na), with minor amounts of calcium (Ca). The gel absorbs water from the surrounding cement paste and expands.
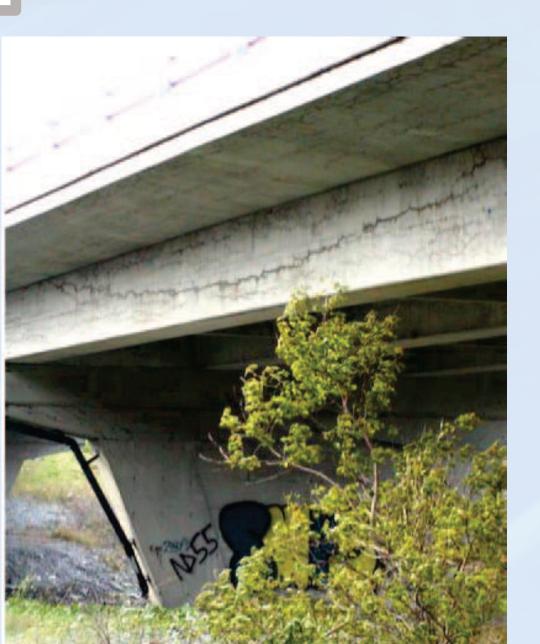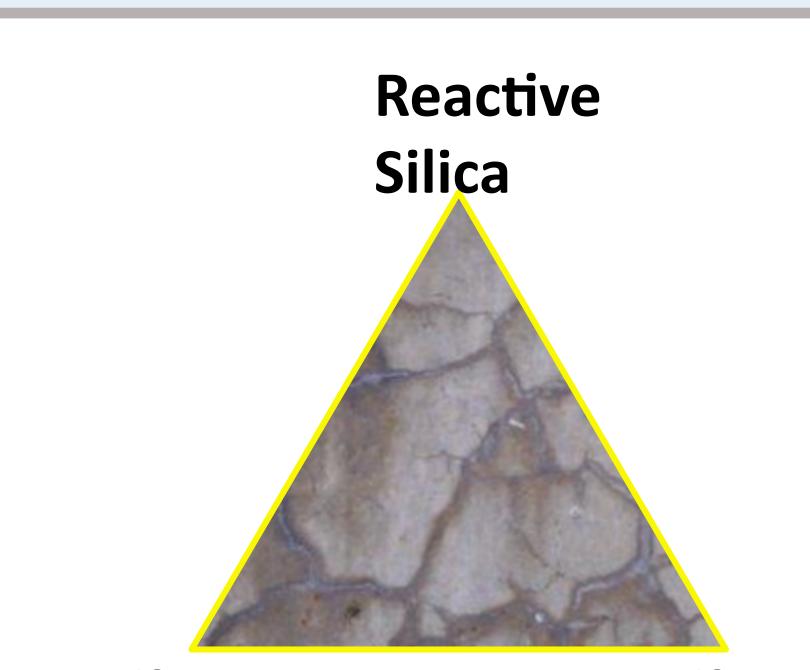

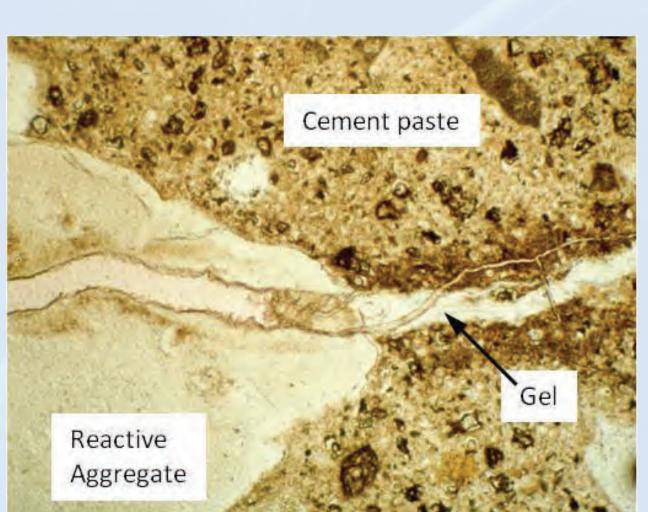**Examples of ASR-affected concrete**
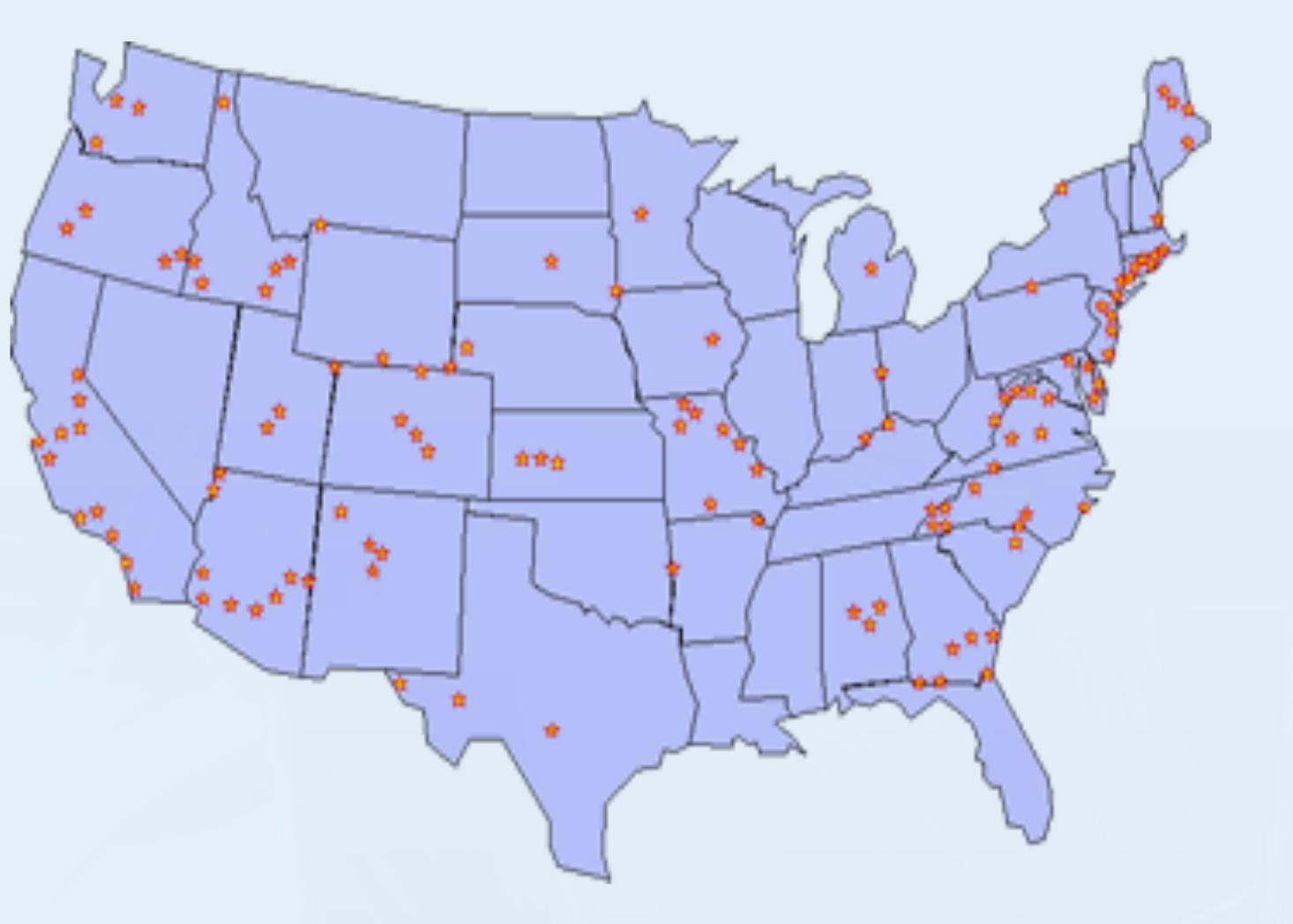

Conditions Essential for ASR

Reactive Minerals
Opal, Tridymite, Cristobalite, Volcanic glass, Cryptocrystalline (or microcrystalline) quartz, Strained quartz
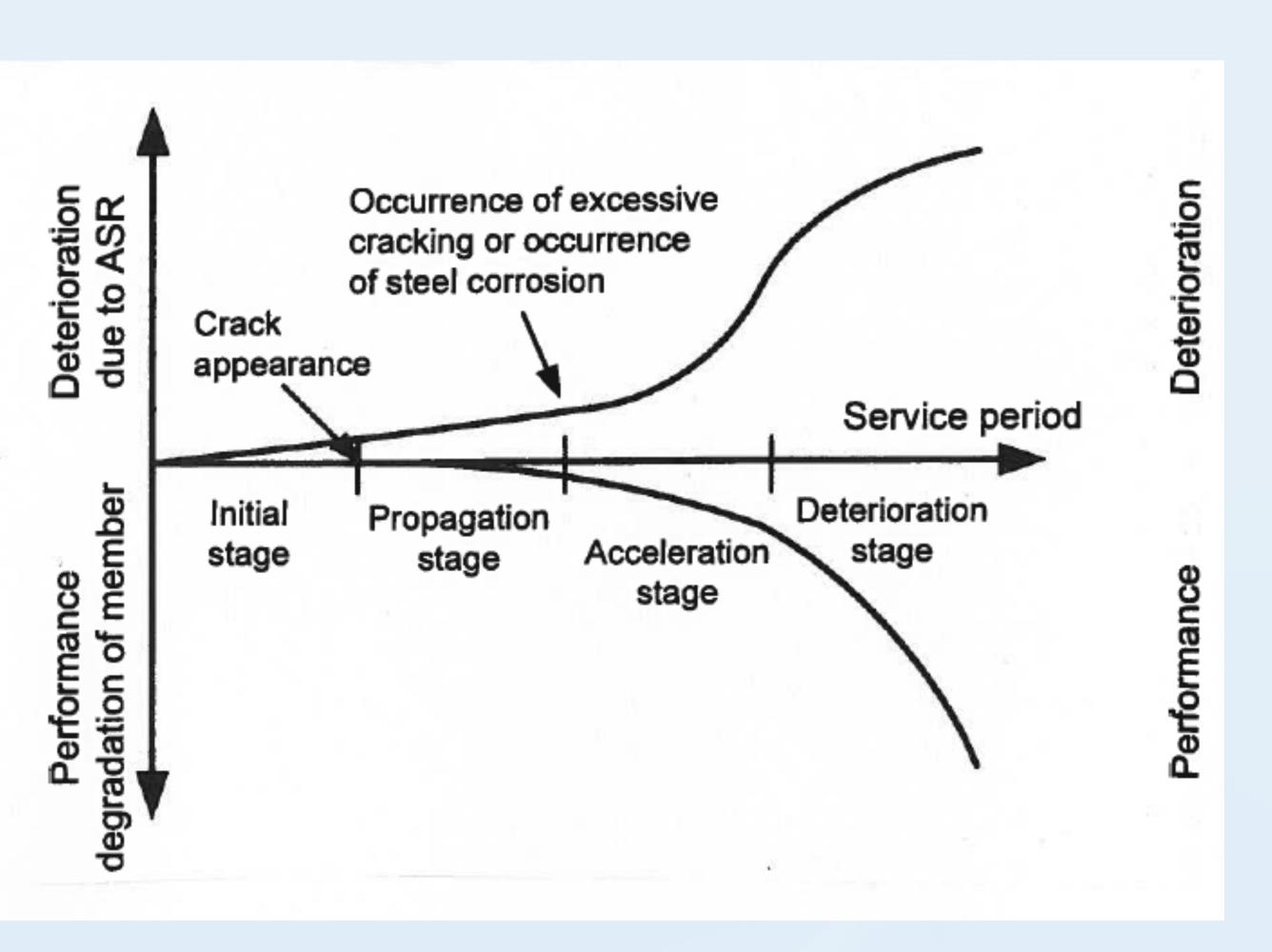

The expanded gel causes internal stresses in the concrete that may lead to cracking of the concrete and changes to its mechanical properties and structural capacity.

Some Reactive Aggregate locations in the United States

Conceptual View of ASR-Affected Structure Deterioration Process

ASR Research at the National Institute of Standards and Technology (NIST)

Objective:
Develop the technical basis and regulatory guidance for U.S. Nuclear Regulatory Commission staff to evaluate ASR (Alkali-Silica Reaction) affected concrete structures. The research will assess the structural performance of ASR-affected concrete structures for design-basis static and dynamic loading and load combinations through its service life, including extended operation for the 20-year license renewal period.

The overall research outcome is to determine, for an existing ASR-affected structure:
1. Its current structural capacity to resist static and dynamic loads, and
2. An estimate of future structural capacity to resist static and dynamic loads.